99P1367

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q 7/30, 7/24

A1

(11) International Publication Number: WO 98/09460

(43) International Publication Date: 5 March 1998 (05.03.98)

(21) International Application Number: PCT/US97/15371

(22) International Filing Date: 28 August 1997 (28.08.97)

(30) Priority Data:
709,244 30 August 1996 (30.08.96) US

(71) Applicant: QUALCOMM INCORPORATED [US/US]; 6455 Lusk Boulevard, San Diego, Ca 92121 (US).

(72) Inventor: ZIV, Noam, A.; 10968 Corte Playa Barcelona, San Diego, CA 92124 (US).

(74) Agents: OGROD, Gregory, D. et al.; Qualcomm Incorporated, 6455 Lusk Boulevard, San Diego, CA 92121 (US).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

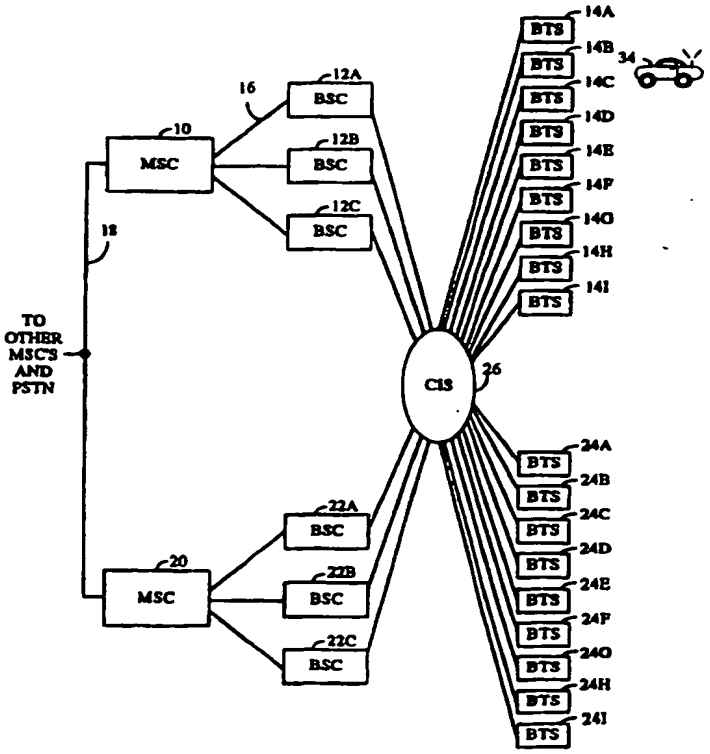
With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD AND APPARATUS FOR DECOUPLING CAPACITY FROM COVERAGE IN A WIRELESS SYSTEM

(57) Abstract

A network providing communication between a public switched telephone network and a remote unit (34) is comprised of a mobile switching center (10, 20). The network also comprises a plurality of base station controllers (12A-C, 22A-C) coupled to the mobile switching center (10, 20). A packet routing entity (26) is coupled to the plurality of base station controllers (12A-I, 24A-I). A plurality of base station transceiver subsystems coupled to the packet routing entity (26). The packet routing entity (26) is capable of passing packets between a first one of the plurality of base station transceivers (14A) and each of the plurality of base station controllers (12A-C, 22A-C). In this way the capacity of the network is decoupled from the coverage area of the network.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania
AM	Armenia
AT	Austria
AU	Australia
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CU	Cuba
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GH	Ghana
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

METHOD AND APPARATUS FOR DECOUPLING CAPACITY FROM COVERAGE IN A WIRELESS SYSTEM

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates generally to network systems, and, more particularly, to a network system employing a packet-switched architecture.

II. Description of the Related Art

Mobile wireless telephone service has been in use for many years. In early cellular systems only a limited number of radio channels were available. Through the use of advanced communications techniques, modern radiotelephone systems have a comparatively large number of radio channels thus increasing the total possible number of contemporaneous connections. Thus, the network which supports the system must also be capable of supporting an increased number of connections. Modern radio telephone systems may be cellular telephone systems, wireless private branch exchange systems (PBX), wireless local loop systems (WLL), personal communication systems (PCS), dispatch or satellite systems. Numerous standards exist for the implementation of modern radiotelephone communications. These standards include Global System for Mobile Communication (GSM) and Code Division Multiple Access (CDMA).

The use of CDMA techniques in a multiple access communication system is disclosed in U.S. Patent No. 4,901,307, issued February 13, 1990, entitled "SPREAD SPECTRUM MULTIPLE ACCESS COMMUNICATION SYSTEM USING SATELLITE OR TERRESTRIAL REPEATERS", assigned to the assignee of the present invention. In the just mentioned patent, a multiple access technique is disclosed where a large number of mobile telephone system users each having a transceiver communicate through satellite repeaters or terrestrial base stations using CDMA spread spectrum communication signals. By using CDMA communications, the same frequency spectrum can be reused multiple times. The use of CDMA results in a much higher spectral efficiency than can be achieved using other multiple access schemes.

A CDMA system can support a large number of simultaneous

connections. Within the system, each call connection must be handled by and routed through a large number of entities within the system. Several different vendors design, build and sell the different entities. The carrier companies may wish to buy the entities from a variety of vendors. Thus, it is advantageous if the entities communicate using a common protocol so that equipment from one vendor may be easily connected to equipment from another vendor. Therefore, industry standard communication protocols are created.

The use of the protocols entices the design of certain compatible hardware configurations. The compatible hardware configurations, however, may not provide the flexibility and call handling capabilities desired from a modern telecommunication system. The present invention provides both compatibility with industry standards and high system reliability.

SUMMARY OF THE INVENTION

The present invention is a method and apparatus by which an additional component is added in a wireless system in order to decouple the capacity of the system with the coverage area of the system. A packet routing network is added to the output of several base station controllers providing interconnectivity between base station controllers and base station transceiver subsystems nominally controlled by another base station controller.

BRIEF DESCRIPTION OF THE DRAWINGS

The features, objects, and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

FIG. 1 is a block diagram of a typical wireless system; and

FIG. 2 is a block diagram of an improved wireless system in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates block diagram of a typical wireless system. Although networks with three or more systems are also within the scope of the present invention, for clarity, the discussion accompanying FIG. 1 describes a dual system network comprised of systems 30 and 32. Also, although the

architecture of the preferred embodiment of the present invention is illustrated in a CDMA-type system, in alternative embodiments other communication systems, such as the Global System for Mobile Communications (GSM), may be used. Systems 30 and 32 may be operated by two different radiotelephone carriers or the systems may be operated by a common carrier. In the preferred embodiment, the system operates in accordance with "Mobile Station-Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System," TIA/EIA/IS-95, generally referred to simply as *IS-95*. (In IS-95 the remote unit is referred to as a mobile station.)

Systems 30 and 32 are comprised of numerous base station transceiver subsystems, eighteen of which are shown explicitly as base station transceiver subsystems (BTS) **14A - 14I** and **24A - 24I**, for communicating with remote unit 34. Each base station transceiver subsystem **14A - 14I** and **24A - 24I** may be partitioned into a number of sectors. Remote unit 34 may be a mobile, portable, personal communication, wireless local loop or other compatible subscriber unit capable of communication with base station transceiver subsystems **14A - 14I** and **24A - 24I**. Telephone calls are routed by base station transceiver subsystems **14A - 14I** between remote unit 34 and base station controllers (BSC) **12A - 12C** of system 30. Telephone calls may also be routed by base station transceiver subsystems **24A - 24I** between remote unit 34 and base station controllers **22A - 22C** of system 32. Base station controllers **12A - 12C** and base station controllers **22A - 22C** connect to mobile switching centers (MSC) 10 and 20, respectively. Mobile switching centers 10 and 20 are connected to the public switched telephone network (PSTN). Once a call has been established, it occupies a signal path from the PSTN through a mobile switching center and base station controller to at least one base station transceiver subsystem. The signal path may change during the call if the call is handed off between base station transceiver subsystems due to the movement of the remote unit within the system. If the system employs "hard" handoffs, the remote unit communicates with only one base station transceiver subsystem at a time. To support a hard handoff, a second fixed path is established to carry the call. If the system employs so-called "soft" handoffs, two or more paths are established simultaneously during the handoff process, thereby requiring multiple paths to be maintained through a plurality of base station transceiver subsystems until the soft handoff is complete. A method and system for providing communication with a remote unit through more than one base station transceiver subsystem during the handoff process are disclosed in

U.S. Patent No. 5,267,261, entitled "MOBILE ASSISTED SOFT HANDOFF IN A CDMA CELLULAR COMMUNICATION SYSTEM," issued November 30, 1993 assigned to the assignee of the present invention.

Each of base station transceiver subsystems **14A - 14I** and **24A - 24I** is comprised of receivers, transmitters, and modems. Base station transceiver subsystems are referred to in the art as a *cell sites* or *base stations*. In the preferred embodiment, data packets are also used on the wireless connection between base station transceiver subsystems **14A - 14I** and **24A - 24I** and remote unit **34**.

On the land side, data packets are transferred to and from base station transceiver subsystems **14A - 14I** under the control of base station controllers **12A - 12C** and mobile switching center **10**. Assume a call is established between unit remote unit **34** and a landline connected to the PSTN. Also assume that remote unit **34** is in the coverage area of both base station transceiver subsystems **14B** and **14C** and, therefore, is in soft handoff. Both base station transceiver subsystems **14B** and **14C** process packets received from remote unit **34** and transmit packets to remote unit **34**. The processed packets are passed to base station controller **12A** from both base station transceiver subsystems **14B** and **14C**. Base station controller **12A** combines the two signals, decodes the signal, and coverts it to the signaling format used by the PSTN. Base station controller **12A** also controls power control on the air interface and co-ordinates intra-BSC handoffs.

Base station controller **12A** passes the signal to mobile switching center **10**. Mobile switching center **10** connects the signal to the proper PSTN line. Mobile switching center **10** also supports call delivery, call features and billing. The link between the base station controller and the base station transceiver subsystem is packet switched in nature in the preferred embodiment. The connection between the mobile switching center and the base station controller may be either packet based or circuit based.

Mobile switching center **10** also provides a connection from the PSTN to base station controller **12A**. Base station controller **12A** receives the PSTN format signaling from mobile switching center **10** and encodes it into packets for transmission over the wireless link. The packets are passed from base station controller **12A** to both base station transceiver subsystems **14B** and **14C**. Both base station transceiver subsystems **14B** and **14C** transmit the packets to remote unit **34**.

When a service provider seeks to set up a network, he needs to purchase the equipment shown in FIG. 1. Several different vendors design, build and sell the different components. In order to provide compatible

components, industry standard communication protocols are created. For example, interface **18** in FIG. 1 is defined in EIA/TIA/IS-41C entitled "Cellular Radio Intersystem Operations" commonly referred to as *IS-41*. Interface **16** is defined in EIA/TIA/IS-634 entitled "MSC-BS Interface for Public 800 MHz" and is commonly referred to as *IS-634*. IS-634 provides a standard of connection between operating regions and supports soft handoff. The use of these protocols seem to lend themselves to the hardware configuration shown in FIG. 1 although other hardware configurations are possible while remaining compliant with IS-634. IS-634 standardizes the messaging, not the link type and, therefore, a variety of link types can be used to provide the connection.

The problem with the configuration shown in FIG. 1 is the resultant close coupling of coverage and capacity. Note that the number of calls that can be handled by base station transceiver subsystems **14A - 14C** is limited to the number of calls that can be handled by base station controller **12A**. Although each base station transceiver subsystem is capable of handling a large number of calls, if the area serviced by base station transceiver subsystems **14A - 14C** is not a high traffic area, efficiency may dictate that base station controller **12A** only be capable of supporting a reasonable number of expected connections. If some event occurs which increases the traffic within the area serviced by base station controller **12A** above the reasonable number of expected connections, the additional connections cannot be supported. The additional connections cannot be supported even if there are idle resources available in base station controller **12B**.

Also problem occurs when one of the IS-634 link connections or one of the base station controllers fails. For example, if connection **16** in FIG. 1 becomes disabled, base station controller **12A** no longer receives signals and no remote unit within the coverage area of base station transceiver subsystems **14A - 14C** can receive or place a call and all existing calls are disconnected. If it is assumed that remote unit **34** is in the coverage area corresponding to both base station transceiver subsystems **14B** and **14C**, remote unit **34** is completely without service.

The area served by one base station controller can be significant. For example, in urban areas, if one mobile switching center or IS-634 link fails, hundreds of square miles can be left without coverage. In the configuration of FIG. 1, capacity and coverage area are directly coupled in that the capacity of a specific coverage area supported by a set of base station transceiver subsystems is limited to the number of connections which can be supported by the base station controller which connects base station transceiver

subsystems to the mobile switching center.

The present invention seeks to remedy these situations by adding an additional component in the design. The additional component decouples capacity from coverage area.

FIG. 2 shows the configuration of the present invention with an additional component, CDMA interconnect subsystem 26. CDMA interconnect subsystem 26 can be any packet routing entity. It receives packets from base station transceiver subsystems 14A - 14I and 24A - 24I and transmits them to base station controllers 12A - 12C and 22A -22C and receive packets from base station controllers 12A - 12C and 22A - 22C and transmits them to base station transceiver subsystem 14A - 14I and 24A - 24I. Because it is a simple packet router, CDMA interconnect subsystem 26 does not add great expense or complexity to the system.

As noted above, the number of base station controllers and base station transceiver subsystems shown in FIG. 1 is arbitrary and typically such systems have more components than shown in FIG. 1. Likewise in FIG. 2, CDMA interconnect subsystem 26 may connect more or fewer base station controllers, more or fewer base station transceiver subsystems and serve more or fewer mobile switching centers.

Note what happens in the configuration of FIG. 2 if connection 16 fails. A call connection can be established, using IS-634 protocol, from the PSTN to MSC 10 to base station controller 12B through CDMA interconnect subsystem 26 and to BTS 14B. MSC 10, aware of the failure of connection 16, begins to send and receive signaling related to the wireless connection between BTS 14B and remote unit 34 to base station controller 12B or any other base station controller having a connection in parallel with the connection between the base station controller corresponding to the failed link and CDMA interconnect subsystem 26. Base station controller 12B performs the same functions that base station controller 12A would have performed.

The same principle applies for the case where the capacity of base station controller 12A is insufficient to support the number of initiated connections. If base station controller 12A has reached maximum capacity, connections for base station transceiver subsystems 14A - 14C can be routed through base station controller 12B or 12C. Notice that the capacity is thus decoupled from coverage in that the capacity of a specific coverage area supported by a set of base station transceiver subsystems is not limited to the number of connections which can be supported by the base station controller which nominally connects the base station transceiver subsystems to the

mobile switching center. Therefore, the total capacity of the system can be shifted to support the coverage areas in which it is required.

In FIG. 2, CIS 26 is shown connecting signals across mobile switching center 10 and mobile switching center 20. In one embodiment, a CIS may be placed across only two BSCs. Because BSCs associated with an MSC are typically clustered physically together, the most advantageous location for a CIS may be across BSCs associated with a single MSC.

The previous description of the preferred embodiments is provided to enable any person skilled in the art to make or use the present invention. The various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without the use of the inventive faculty. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

I CLAIM:

CLAIMS

1. A network providing communication between a public switched telephone network and a remote unit comprising:

a mobile switching center;

a plurality of base station controllers coupled to said mobile switching center;

an packet routing entity coupled to said plurality of base station controllers; and

a plurality of base station transceiver subsystems coupled to said packet routing entity, wherein said packet routing entity is capable of passing packets between a first one of said plurality of base station transceivers and each of said plurality of base station controllers.

2. The network of claim 1 further comprising:

a second mobile switching center; and

a second plurality of base station controllers coupled to said second mobile switching center and coupled to said packet routing entity such that said packet routing entity is capable of passing packets between said first one of said plurality of base station transceivers and each of said second plurality of base station controllers.

3. A method of decoupling capacity from coverage in a cellular system comprising the steps of:

establishing a first connection between a unit connected to a public switched telephone network and a remote unit through a mobile switching center, a first base station controller, a packet routing network and a first base station; and

establishing a second connection between a second unit connected to said public switched telephone network and a second remote unit through said mobile switching center, a second base station controller, said packet routing network and said first base station.

4. A method of decoupling capacity from coverage in a cellular system comprising the steps of:

establishing a first connection between a unit connected to a public

switched telephone network and a remote unit through a mobile switching center, a first base station controller, a packet routing network and a first base station; and

establishing a second connection between a second unit connected to said public switched telephone network and a second remote unit through a second mobile switching center, a second base station controller, said packet routing network and said first base station.

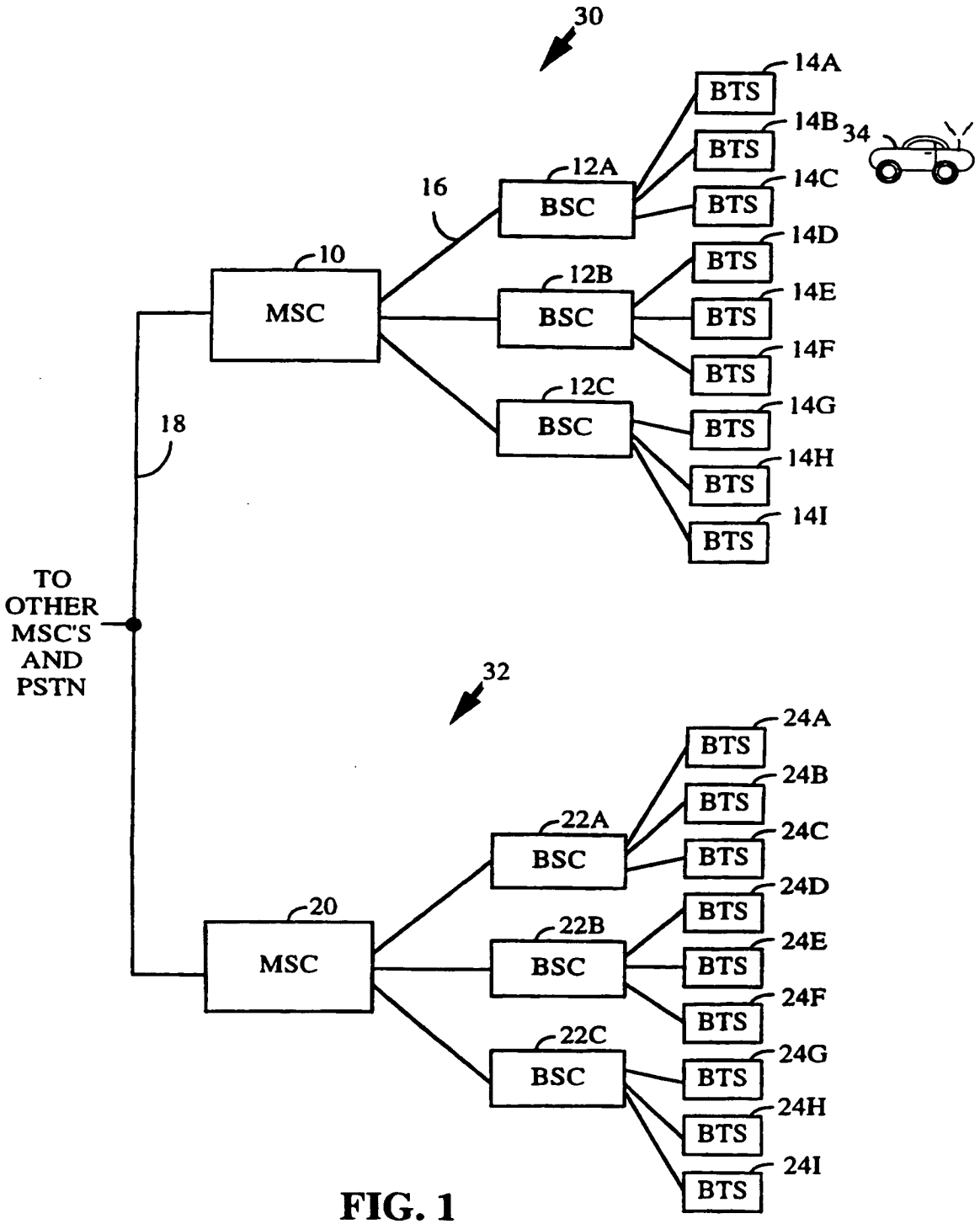


FIG. 1
PRIOR ART

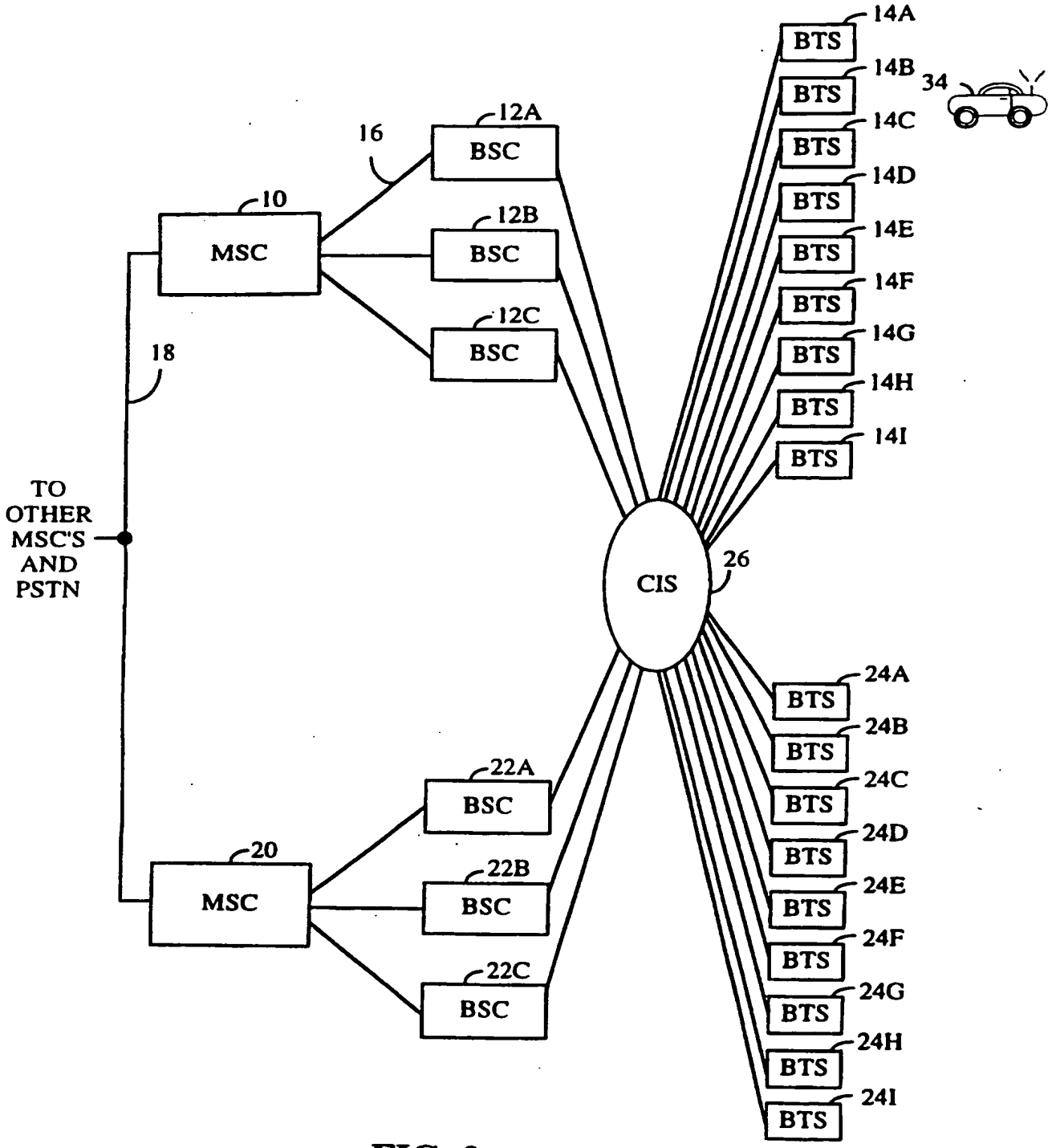

14A
BTS
14B
BTS
34
14C
BTS
14D
BTS
14E
BTS
14F
BTS
14G
BTS
14H
BTS
14I
BTS
12A
BSC
16
10
MSC
12B
BSC
12C
BSC
18
TO
OTHER
MSC'S
AND
PSTN
CIS
26
24A
BTS
24B
BTS
24C
BTS
24D
BTS
24E
BTS
24F
BTS
24G
BTS
24H
BTS
24I
BTS
22A
BSC
20
MSC
22B
BSC
22C
BSC

FIG. 2

INTERNATIONAL SEARCH REPORT

Intern. al Application No
PCT/US 97/15371

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/30 H04Q7/24

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 534 716 A (NIPPON ELECTRIC CO) 31 March 1993 see column 2, line 11 - line 45	1,3
A	see column 3, line 7 - column 4, line 22	2,4
A	WO 94 00959 A (NOKIA TELECOMMUNICATIONS OY ;TAHKOKORPI MARKKU (FI)) 6 January 1994 see page 3, line 15 - page 5, line 10 see page 8, line 4 - page 9, line 30	1-4
E	EP 0 796 022 A (MOTOROLA INC) 17 September 1997 see column 4, line 33 - column 7, line 58	1,3

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publicationdate of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Date of the actual completion of theinternational search	Date of mailing of the international search report
12 February 1998	18/02/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Baas, G

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 97/15371

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0534716 A	31-03-93	JP 5091035 A	09-04-93
		US 5619551 A	08-04-97
WO 9400959 A	06-01-94	FI 96565 B	29-03-96
		AU 668744 B	16-05-96
		AU 4502593 A	24-01-94
		EP 0648402 A	19-04-95
		JP 7508379 T	14-09-95
		US 5678178 A	14-10-97
EP 0796022 A	17-09-97	NONE	